

2003 WSDOT CAE Review Report & Recommendations

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2003 WSDOT CAE Review Report & Recommendations

Introduction

This report presents findings and recommendations from a performance review of Computer Aided Engineering “CAE” technologies. A proposal to conduct this review was presented to and endorsed by the Project Development Engineers at their June 2003 conference. The review was conducted in October through December 2003.

The purpose of the review was to measure WSDOT performance of selected project delivery activities in conjunction with the data, technologies, and procedures that support these activities. The goal was to identify both problem areas and successes, and gather information to help guide planning for the future.

Scope of Review

The scope included the following processes typically performed by region design and construction offices.

- *Project Data Collection*
- *Project Design*
- *Plans Preparation*
- *Plan Review & Processing to Ad*
- *Construction*

Process Overview

A technical team of HQ & Region CAE staff distributed a department-wide web survey and conducted eleven interview sessions across the state to gather input. The web survey received 396 responses, and 101 people attended interview sessions. The majority of participants have more than 10 years of experience and work in region project offices.

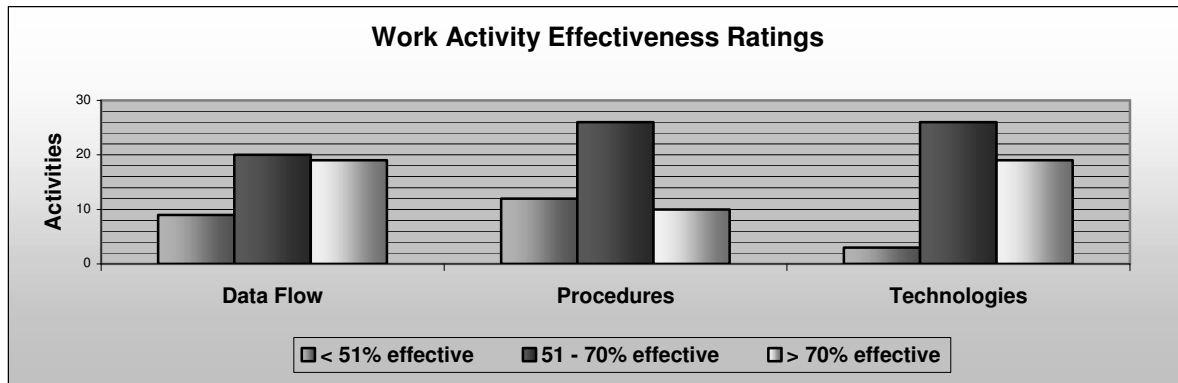
Forum	< 1 yr	1 to 3	3 to 10 yrs	> 10 yrs	Unknown
Web Survey Participants	10	74	86	216	0
Interviews Participants	1	6	24	55	15

Table 1 - Years of Experience of CAE Review participants

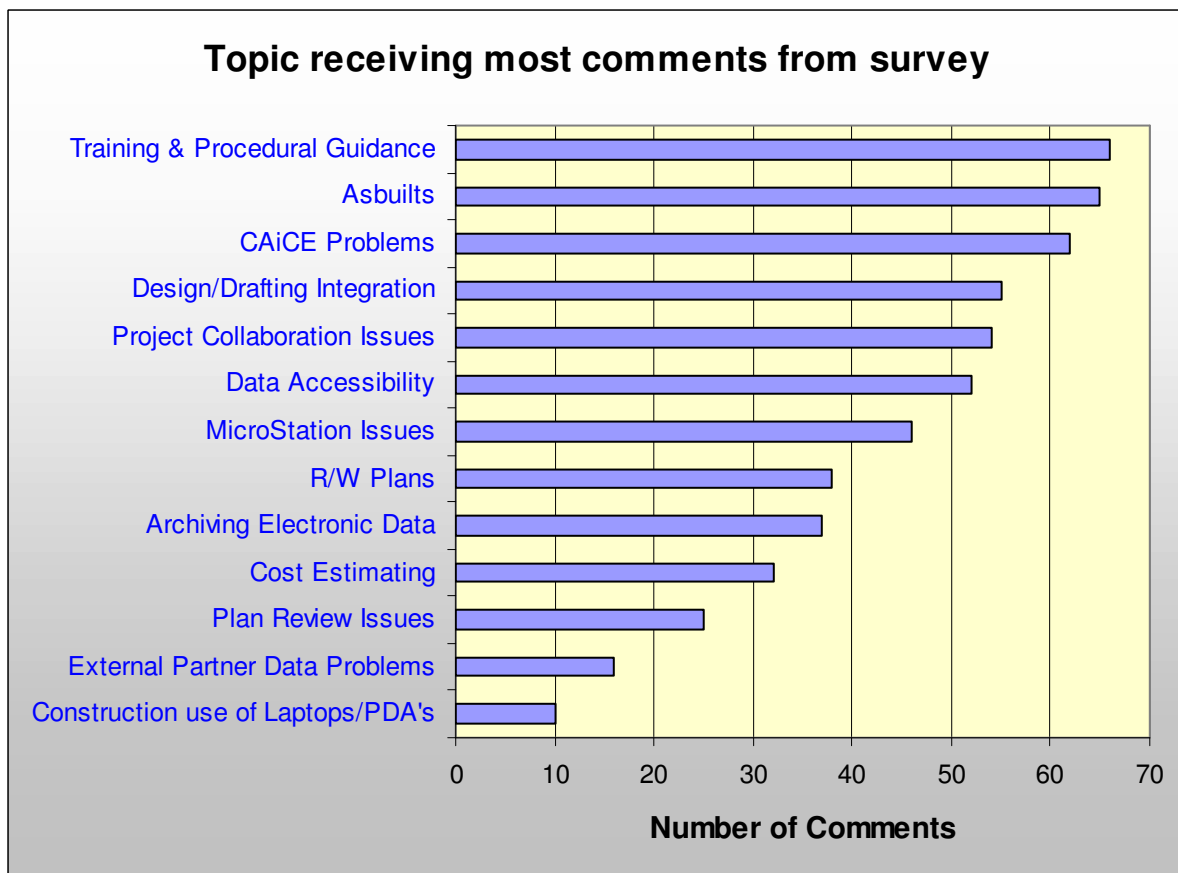
The team conducted research on industry trends. Information is presented on civil software other transportation agencies and consultants are using. Autodesk and Bentley Systems also participated in the review and each gave presentations on the future direction of civil software development for their company.

Summary of Survey Results

The survey asked people to rate the effectiveness of 48 project delivery work activities. Participants rated the effectiveness of data flow, procedures and technologies. The following chart summarizes the results of the ratings. See Appendix B for detailed survey results.



The survey also contained several open-ended questions asking input on how to improve the activities. These questions generated nearly 500 written comments and suggestions. The following chart indicates the topics receiving the most comments.



Civil Software Industry Trends & Data

When WSDOT was pursuing a replacement for the CEAL software in 1996, there were approximately seven vendors competing for the design software RFP. Today, Autodesk & Bentley combined own five of those seven products that were available from independent vendors in 1996. Of the two remaining solutions, EaglePoint is the only other independent vendor. Eagle Point has been in use by many County jurisdictions in Washington for several years. It is not likely to meet the more complex design requirements of WSDOT.

Civil Software Vendor Presentations

Bentley and Autodesk gave presentations on their current technologies, future direction, and how their current solutions might address some of the review findings. A brief synopsis follows; some information cannot be included because of non-disclosure requirements.

Bentley Systems

Bentley presented current technology for a “managed” environment solution to meet the project collaboration and data management gaps identified in the findings. In the managed environment, ProjectWise controls all engineering files and data for all Bentley applications. As survey, design, and CAD files are updated, they are saved into ProjectWise, which maintains file security by allowing access to selected users. Other components of their managed environment, Digital InterPlot & Publisher, were demonstrated for managing digital plans allowing less reliance on the use of paper plans for review, redline, and publishing.

They presented their plan for continued development and enhancement of all three Bentley civil design solutions, InRoads, GEOPAK, & MxRoads. As new modules are developed they will function with all three applications and have the same look and feel. Examples of this were demonstrated with Quantity Management and Roadway Modeling modules. Over time the three applications will become more similar until at some point there will likely be one application. They plan for this to evolve over many years and to be a seamless migration for the user.

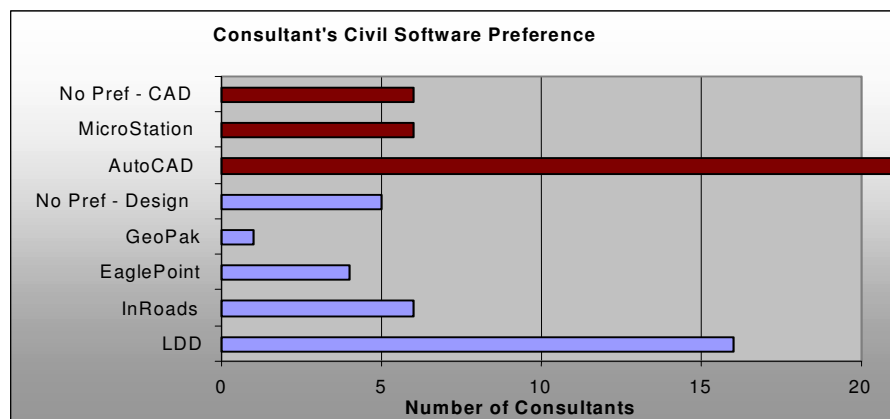
Autodesk

Autodesk presented how their integrated CAD and GIS provide a complete solution to managing data through the entire infrastructure lifecycle with less data loss and re-creation at each milestone. The Buzzsaw product was described as a solution to address our project collaboration and data management issues.

They presented their plan to support & maintain CAiCE over the next several years and the roadmap for Civil 3D development. CAiCE and Land Desktop will be replaced by Civil 3D at some point in the future. A preview version of Civil 3D was demonstrated showing the interactive modeling capabilities that creates intelligent relationships between design elements. As design elements are modified, all other related design elements are dynamically updated. It was also demonstrated how Civil 3D will produce a three-dimensional project model for download into machine control systems to guide GPS controlled grading equipment.

Consultant Engineering Firms

A consultant survey, see Appendix C, was distributed and received feedback about the civil software they use and their experience working with WSDOT. Over 35 firms responded and 27 have preferred design and CAD software. Land Desktop and AutoCAD are the prevailing preference, particularly with smaller firms, with InRoads and MicroStation the second choice. Six firms indicated they have no preference and use the software specified by their clients.



WSDOT staff report that working with consultant engineering files is a problem area, even though we require consultants to deliver in MicroStation and CAiCE formats that adhere to our data standards. Firms were asked how they meet this requirement. Approximately 50% said they use CAiCE & MicroStation for our projects. The others use their preferred software and convert, have not been required to deliver per the contract, or did not respond.

Civil Software used by other Transportation Agencies

The charts below indicate the design software used by other State DOT's and Washington counties. CAD software is not shown on the charts, however 47 State DOT's use MicroStation, and AutoCAD is the choice with the majority of Washington counties.

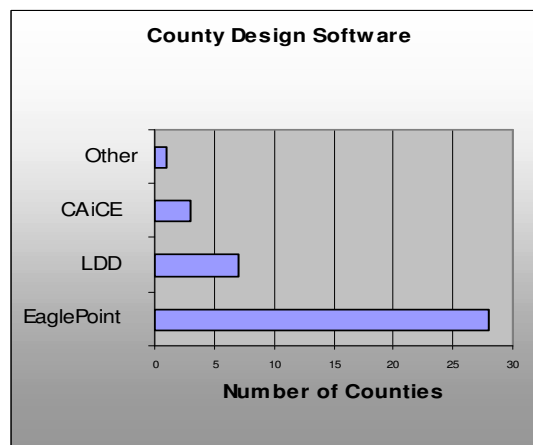
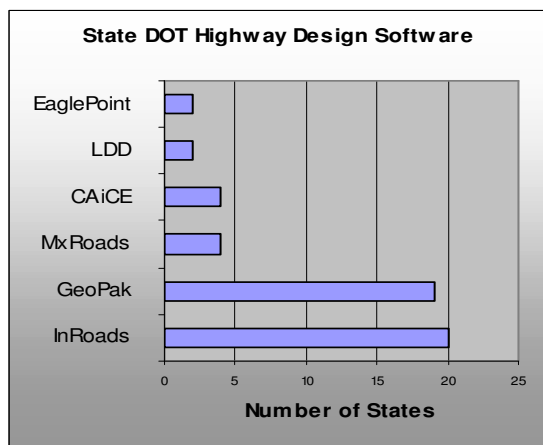


Chart notes: Autodesk owns LDD (Land Desktop), CAiCE & AutoCAD. Bentley System owns InRoads, GEOPAK, MxRoads, and MicroStation.

Survey & Construction Technology

Survey Technology

The pace of surveying technology advancement has slowed down after major advances in the 90's. The industry is now learning how to apply the current technology in more efficient ways. Total stations are becoming easier to use and the advent of prismless technology has resulted in more efficient and safer surveying.

GPS is getting easier to use, more accurate, and less expensive. Efficiency using GPS will continue to grow with implementation of continuously operating Virtual Reference System "VRS" networks. VRS will reduce the need for base station setups and the cost of this additional equipment. VRS will increase the accuracy of inventory grade GPS data collection and will eventually result in more accurate inventory data in GIS systems. The integration of GPS technology with "conventional" survey methods will also continue to improve.

Ground based laser scanning data collection technology has been around for several years. This technology records an accurate three-dimensional image of anything within its scanning range. The technology is continuing to improve and the cost is dropping. It is likely to become a viable tool for traditional topography surveying in the near future, and for some types of projects should be considered today.

Machine control technology on grading equipment will change the way the WSDOT does construction staking in the future. This technology relies on an accurate digital terrain model of the project and GPS to operate the onboard machine control to grade design surfaces within a few centimeters' accuracy. Field staking by construction surveyors may become a process of the past.

Project designers will also need to keep this technology in mind because of the requirements for an accurate digital terrain model "DTM" that can be correctly downloaded into machine control systems. It may also require WSDOT construction office personnel to become more skilled with design software.

Construction Administration Technology

Construction administration is an information intensive process and presents opportunities for technology solutions to gain efficiencies and possibly avoid some construction claims. Tablet PC's, workflow software, and wireless networking are a few technologies with potential in this arena.

Based on some limited research it appears that construction use of IT in the field is still in its infancy. California, Utah, Michigan, and Maryland are a few states that have implemented technology in the field. The trend is generally focused on activities such as: Materials & Quantity Tracking, Inspection Reports, and Request For Information. Oregon DOT is doing some planning in this area but expressed similar concerns to WSDOT personnel regarding screen visibility, security, and weather issues.

Further evaluation and research on how others are applying technology in construction administration is needed. Setting up some WSDOT construction offices to pilot test various technologies would also provide good information on benefits and problems.

Recommendations

Recommendations are based on the staff feedback and industry data that was collected along with the review team's professional knowledge. The recommendations have not been prioritized, nor has cost to implement been considered. The review resulted in feedback about issues having no direct relationship to CAE technologies or area of responsibility. Recommendations are presented for these issues because some have an impact on effective use of CAE technologies.

Several recommendations apply agency wide and should be implemented agency wide. These are likely to have a higher cost or operational impact and will require senior management leadership to influence change and make a decision to implement.

Other recommendations are for region, business unit, and technical group managers to evaluate and implement. Some of these do not apply in all regions, as the issue may not be prevalent due to size and operational differences.

Readers are encouraged to review the findings in Appendix A because there are issues not addressed by recommendations in this report. There may be other solutions to address some of these.

Project Collaboration and Data Management

Recommendation 1.1

Define, institute, and enforce standard file naming conventions, documentation/file cleanup procedures, and handoff procedures for electronic project data at major milestones. Include documentation on design decisions and commitments that downstream activities need to know about.

This will help ensure that those performing downstream work activities can find, interpret, and use the data from the previous activity. The handoff from design to construction should be the first area of focus. Naming conventions and documentation standards should be defined agency wide. Project handoff procedures may need to be defined on a regional basis because of the variability in how different regions conduct business.

From Findings; B2, B3, B5, B7, W3. Note: A team is currently working on file naming and documentations.

Recommendation 1.2

Implement engineering file management technology for systematically managing engineering information to prevent data loss and improve future accessibility.

This will result in the benefits listed below and address a large concern shared by many people.

- Ensure that engineering files are not lost, accidentally deleted, or mistakenly overwritten while the project is in progress.
- Make project files, such as CAD basemaps, accessible to others working on the project as updates are posted and communicated to stakeholders.
- Provide the means for archiving project files at project milestones, ensuring that the project data is accessible for future tort claims, future projects, agency inventory systems and GIS (see recommendation 2.1).

From Findings; A4, A5, S2, S3, W1, W2, W4, W5

Recommendation 1.3

Encourage project design offices to involve support offices early in projects and keep them updated with changes. Encourage project support offices to provide guidance to design offices that describes their supporting role in project delivery and their information and schedule requirements.

Implement recommendation 1.6 to help make support office contact information and region procedural guidance more accessible to new design staff. Implement recommendation 1.2 to give support offices access to current project basemap and other project data.

From Finding; A3

Recommendation 1.4

Encourage project designers and surveyors to discuss project data needs early in the design process.

Surveyors need to provide good documentation for their survey data to prevent rework in the event that a project is shelved and survey crews change. Survey crew stability (see recommendation 4.2) would also benefit these activities.

From Findings; C1, C2, C3

Recommendation 1.5

Encourage design and construction offices to discuss construction data needs that design can produce to be more useful for staking the project and administering the contract.

This will become even more important with advancement and availability of machine control technology because contractors will want digital terrain models for projects to operate GPS controlled grading equipment.

From Findings; B3, B4, B6, B7, O2

Recommendation 1.6

Enhance region intranet pages to provide current names of region contacts, region procedural guidance, and region specific data that are available. Enhance intranet pages of HQ business units providing project services to include current information about contacts for different services, current projects, available data, and procedural guidance.

An interesting observation of the interview session was the number of participants that found out about existing information by hearing from other region staff in attendance. HQ Bridge and Ad Ready were specifically mentioned as offices that people don't know whom to contact for services, current project status, and other information.

From Findings; A1, A2, E1, E2, E3, G3, G4, T4

Recommendation 1.7

Implement technology for electronic distribution, review/redline, and digital signatures of plan sets.

This technology will support those that want to move toward a paperless environment to gain efficiencies in plan review and reduce paper waste. This will not replace hard copy review as many people will prefer and continue to work with hard copy plans. Redlining technology could save

time for designers who are currently expending a lot of effort managing review comments on large projects.

Bridge plan review in particular was mentioned as an opportunity to reduce review time simply by posting bridge plans on the intranet. This would reduce wait time for ground transportation delivery of hard copy plan sets and is a minimal cost solution to implement.

From Findings; D3, D4, D5, G2

Data Accessibility

Recommendation 2.1

Establish a long-term goal to improve data accessibility for project development by providing one stop, easy access to information. Prepare for future integration of engineering data with GIS.

Fulfillment of these objectives will result in time saving efficiencies, particularly in the early data collection phases of project development. The intranet and GIS are two technologies that present opportunities for accomplishing this goal. The use of GIS is nearly non-existent in project development because the data is not engineering accurate and GIS & CAD technologies do not “talk” to each other very well. GIS and CAD technologies have evolved and can now share and edit the same data, which will eventually increase GIS data accuracy as engineering data becomes more accessible. One of the first uses of this compatibility will be to display project CAD data to the public via the Internet through GIS. This recommendation supports continued development of the GIS Workbench project that is currently underway.

From Findings; E1, E2, E3, E4, E5

Recommendation 2.2

Provide training and marketing to encourage people to use the WSDOT intranet as an information resource. Improve intranet web sites to make information easier to find.

There is information available that people don’t know exists or don’t take the time to find because they don’t know when new information is posted. Suppliers of the intranet need to keep information current, communicate the posting of new information, and ensure their sites have intuitive navigation for finding information.

From Findings; AB9

Working with Consultants

Recommendation 3.1

Hold consultants accountable for delivering electronic engineering files per our contract requirements. Conduct more thorough review of consultant design at interim review points. Ensure that WSDOT personnel accepting consultant designs are trained to review the electronic engineering files, or have resources available to review the files before final acceptance of the project.

The Department will continue to waste time when our staff need to work with or modify consultant files if this issue is not addressed.

From Findings; I2, I2, I3

Recommendation 3.2

Evaluate options to help consultants meet our electronic engineering deliverable requirements. Options to consider include LandXML, changing our standards, and developing custom WSDOT AutoCAD standards.

Options to consider include:

- Evaluating LandXML to determine if an acceptable data exchange format could be developed.
- Developing WSDOT AutoCAD standards for consultants to use.
- Changing our CAE software standard for better alignment with consultants; Land Desktop/AutoCAD and InRoads/MicroStation appear to be favored by consultants in Washington.
- Changing our standard for CAD plan sheets to increase alignment with how consultants produce CAD plan sheets.

From Findings; I1, I2

Recommendation 3.3

Encourage local agencies to require WSDOT standards for electronic engineering files when they hire consultants for design work on state highways and WSDOT is administering the construction contract.

Our construction personnel are spending extra time working with the data from these projects because it does not follow our standards.

From Finding; J1

Technology

Recommendation 4.1

WSDOT should seriously consider moving to an integrated software suite for roadway design and drafting to gain efficiencies.

CAiCE and MicroStation are meeting the needs of project delivery, but there are several inefficiencies in the current environment. An integrated suite would offer the following benefits.

- Eliminate data transfers and duplication of work with seamless data integration.
- Reduce the learning curve for CAD Operators moving into design positions because the look and feel of the software interface would be consistent.
- Increase efficiency for designers who use both applications.
- Reduce technical support and training needs.
- Eliminate software upgrade compatibility issues.

Implementing this recommendation would also present an opportunity to better align with consultants and potentially find software that is not as difficult to learn as CAiCE; which is a consistent concern from the findings.

From Findings; K2, K3, K4, K5, K6

Recommendation 4.2

Encourage survey crew stability and maintain experienced party chiefs.

Survey technology has changed our procedures and less time is required for low skill tasks such as chopping brush, and holding the end of a chain. Ad hoc survey crews should be discouraged and the experience of existing survey crew members should be considered before placing inexperienced staff on crews. The review clearly pointed out that regions with experienced party chiefs and crews were more successful.

From Findings; C3, AA2, AA5

Recommendation 4.3

Ensure that training, change documentation, and procedural guidance are available before implementing new technology or releasing major engineering software upgrades.

Coordination with existing WSDOT technologies also needs to be carefully evaluated before implementation.

From Findings; Q2, Q3, Q4, AA3, AA4

Recommendation 4.4

Develop a more comprehensive WSDOT standard level structure using the unlimited level capability in MicroStation V8.

Ease of level management, user definable levels, and consultant standards need to be considered in developing a new level structure standard.

From Findings; R1, R2, S1

Recommendation 4.5

Electronically link common data in quantity & estimate applications to eliminate redundant entry of quantity data and reduce errors.

From Findings; T3

Recommendation 4.6

Set up some construction offices to pilot test technologies for contract administration.

It is the review team's opinion that construction personnel are not informed on what technology is available that could increase the efficiency of their work. Tablet PC's, wireless communications, and workflow software, are technologies that should be evaluated. Pilot tests would identify added value and help answer implementation decisions. One inexpensive technology that could be of benefit is to supply inspectors with digital voice recorders.

From Findings; U

Procedural Issues

Recommendation 5.1

Improve the usability and quality of asbuilt information. Existing hard copy asbuilt drawings should be scanned and made available electronically. Management should consider developing policy for future asbuilt documentation to be produced in the project design CAD file for the benefit of future projects. Improving the quality of asbuilt information should be given a higher priority.

Asbuilts are a large area of concern for many. Asbuilts in CAD are important if the Department wants to implement an efficient, complete lifecycle approach to store and manage infrastructure data for future maintenance, operations, planning, and project development.

From Findings; V1, V3

Recommendation 5.2

Give higher priority and allow adequate time in project schedules for project closure, data clean up, and record keeping activities at major milestones.

Project managers and schedules need to allow time to ensure this work gets completed. People indicated the next project is more important than taking care of project closure and cleanup activities. Cleanup and archiving of project files and recording of asbuilt information are two activities that are suffering because of this issue.

From Findings; V2, W3, W7

Recommendation 5.3

Evaluate the current process for managing R/W plan information and R/W CAD files looking for opportunities to modernize.

There are likely technical solutions for making improvements while still meeting the legal document requirements. Many people have concerns about an inefficient R/W plan process that they consider outdated.

From Findings; X1, X2, X3

Recommendation 5.4

Update the Plan Prep Manual to fix inconsistencies, provide better examples, and ensure the CAD standards are up to date with electronic resources.

An update is currently underway as a result of review.

From Findings; Y1, Y4

Training

Recommendation 6.1

Project managers need to ensure that people attending training can apply what they have learned immediately. Training should be scheduled appropriately to accommodate timely application on projects. Self-teaching training materials should be developed to supplement instructor training as a “just-in-time” training resource and refresh aid.

A common concern from people is they are attending training but not able to apply because their project is not at the point where the training can be used and they forget what was learned by the

time it can be applied. Self-teaching training tools can be delivered when needed to supplement instructor led training. Those who have used the multimedia training that is available liked the concept and encouraged more development of that type of training.

From Findings; AB2, AB3

Recommendation 6.2

Mentoring should be strongly encouraged as a method for people to learn project delivery procedures and technical tools.

Mentoring and self-teaching are very common methods that people are using to learn their jobs and the technologies. In many cases this is the primary method that people are using to learn how to use CAE technologies.

From Findings; AB5, AB12

Recommendation 6.3

Develop and deliver more training on basic principles of design, drafting and surveying.

Less experienced staff don't always understand the theory behind the results the technology is calculating, or why things are done a certain way, even though they may know how to "push the buttons" to produce a result.

From Findings; AB6, AB7

Recommendation 6.4

Develop training for CAiCE that is focused on; use in construction, earthwork processing, and data transfers to MicroStation.

These are areas where people are struggling with using CAiCE.

- Many construction offices don't have personnel that are experienced with CAiCE and are not able to work with the CAiCE project that design supplies to them for contract administration and staking data.
- The earthwork process is one of the most difficult processes to perform in CAiCE which many people struggle with.
- Training in the correct use of feature codes in CAiCE could eliminate some duplication of work in MicroStation.

From Findings; B7, O3

Appendix A: Summary of Findings from Written & Verbal Feedback

The findings represent the input the review team received from the written comments in the survey and the verbal comments from the interview sessions. The interview sessions were structured to focus on problem areas identified from the survey. The findings are organized by the categories listed below and are detailed in the sections that follow.

1. Project Collaboration
2. Data
3. Technology
4. Training & Procedural

The issues within each category are identified by letters and underlined text. The numbered statements represent the findings. The numbers are only used for reference purposes, not to represent priority or importance.

It's important to keep in mind the findings are based on people's personal experiences. Some may have worked in a variety of offices and regions, while others may have only worked in one office. Some comments may be based on past experiences that may not necessarily be true today. The findings will also not necessarily be true for all regions.

Project Collaboration

A) Communication/coordination with project support offices:

1. Communication and coordination is strongly based on relationships and experience, not defined process or procedures.
2. This issue is much more of a problem in larger regions, as people are more likely not to know whom to contact.
3. Support offices don't feel they are involved early on in projects. R/W in particular was adamant about the importance of early involvement.
4. There are problems with managing & communicating changes to project basemaps between design offices and support offices.
5. Problems are occurring with coordination and overwriting of engineering files within project offices.

B) Project handoff from Design to Construction:

1. PEO's constructing the projects they design are more successful with this issue.
2. Procedures and documentation are lacking for hand-off of project data.
3. Design data is not "cleaned up" or documented for construction.
4. Design is focused on plan quantities, not necessarily on developing "construction ready" cross-sections and Digital Terrain Models.
5. Construction is not getting documentation about design decisions.
6. There is a lack of trust towards design by construction.
7. Construction is doing a lot of re-design, partly because of the items identified above.

C) Coordination between Survey and Design

1. Designers and surveyors are not always communicating about project data needs.
2. Documented procedures for data flow between surveyors and designers are needed.

3. In some regions, survey crew turnover is leading to communication problems and rework because of the lack of documentation and lack of trust. Regions with stable experienced crews, particularly party chiefs, experience far less problems.

D) Plan Review and Plan Processing

1. Review seems to be more focused on cosmetics rather than constructability.
2. Inconsistency in the Plans Prep Manual is causing interpretation issues.
3. Managing review comments is very time consuming on large projects.
4. People are generally supportive of using electronic distribution of plan sets for review. Some people think it would reduce time and effort to distribute plans and waste less paper.
5. There was mixed reaction to the value of electronic red lining tools for plan review and the use of electronic signature technology for final contract plans.

Data

E) Improve Data Sharing:

1. Finding information requires a lot of digging and research. It's not easy, not automated, not documented, and there are many different sources and applications.
2. Finding data is based on relationships and experience, rather than documented processes and procedures.
3. Data exists in some cases - people are just not aware it exists or how to access it.
4. People would like to have one-stop access to data using GIS & the intranet.
5. Time to find and sort through data impacts project schedules.

F) Accident/Traffic Data:

1. There is poor accessibility to accident and traffic data. MicroCars was a better system.
2. People find it difficult and time consuming to decipher accident data report and various codes.

G) Bridge Software:

1. People are resigned to the fact that Bridge uses different design software, but see some benefit for them to use the same software and share data electronically.
2. People suggested that Bridge distribute PDF files for review rather than mailing hard copy in order to speed up review time.
3. Designers don't always know who to contact in Bridge
4. The timeliness of Bridges' response to various issues is a concern.

H) Utility Issues:

1. Utility relocations impact project schedules.
2. Utility data is often incorrect and/or not up-to-date.
3. Much of utility company data is in AutoCAD.
4. People liked working with utility companies that use GIS to manage their data.

I) Consultants:

1. Some consultants use their preferred design software for WSDOT projects and convert to CAiCE & MicroStation formats to meet WSDOT requirements. Data intelligence is lost in the conversion process resulting in rework by WSDOT.

2. Some consultants are not adhering to contract boilerplate language for electronic deliverables. WSDOT is accepting deliverables without holding them accountable to the contract. Those accepting the work may not know if deliverables meet our standards
3. There are problems getting additional or supporting information from consultants after WSDOT acceptance of contract without being billed.
4. There is a perception that consultants, in general, are delivering poor quality designs and data. They are not being held accountable even though rework and field fit is needed on some of these projects.

J) Local Agencies

1. Local agencies are hiring consultants to do work on state highways and not requiring them to use WSDOT's electronic deliverable standards.

Technology

K) Design/Drafting Software Integration:

1. Having a single platform is very important to some but not to others.
2. Seamless integration of design and drafting data is very important.
3. Two platforms create a greater learning curve. More training is required to move from MicroStation to CAiCE than it would with a single platform.
4. Some duplication of work is occurring. Cleanup of CAiCE graphics is required when transferred to MicroStation.
5. Staggered CAiCE & MicroStation upgrades are creating extra work and frustration.
6. Some people are using both CAiCE & MicroStation for design, because some geometric design tasks are easier to do with MicroStation.
7. There were accuracy issues moving data between older versions of CAiCE and MicroStation, but this problem has been resolved with the latest versions of CAiCE and MicroStation.

L) CAiCE Earthwork:

1. CAiCE's earthwork process has improved from earlier versions.
2. The earthwork process is cumbersome and difficult to learn, but some consider it powerful.
3. People were most successful when they kept their earthwork design simple by breaking projects into smaller segments and separating earthwork quantities from surfacing quantity runs. Some are using Excel and MicroStation for surfacing.
4. Some distrust the accuracy of earthwork quantity results. Those who have performed manual checks were not able to confirm that the earthwork results were incorrect.

M) CAiCE General Issues & User Friendliness:

1. There was mixed reaction to user friendliness, depending on people's experience level with using CAiCE.
2. CAiCE's user interface has improved from earlier versions but is still not intuitive, with inconsistent command structure and dialog boxes.
3. People consider CAiCE to be complex but powerful, with a large learning curve
4. The Help system is not helpful. The error messages are not clear.
5. There is a long turnaround time getting technical issues resolved by CAiCE
6. There are some data transfer issues between newer versions of CAiCE and Trimble

N) CAiCE Fragments:

1. There are positive comments about Visual Basic fragment technology.
2. Not everyone is using the VB fragments because of ongoing projects
3. Not everyone understood that fragments are developed by WSDOT, not Autodesk.

O) CAiCE for Construction & Staking:

1. There is mixed reaction to the staking report. Some people find it useful. Others desire more flexibility in creating the report. There is some manual manipulation of staking data occurring to get desirable format. Some crews don't use the staking report and are calculating directly from the plans.
2. Design & Construction offices are not always communicating on staking needs for construction.
3. Some construction offices lack staff with CAiCE experience and struggle with using the electronic data for construction.

P) CAiCE X-section Plotting

1. Scaling and text formatting are cumbersome and inflexible in CAiCE.
2. Plotting results are inconsistent depending on the plotter.
3. Most people transfer cross-sections to MicroStation for cleanup and plotting.

Q) MicroStation General Issues:

1. People found new features in V8 to be valuable to plans production.
2. Some find the level manager and raster tools to be more complicated in V8.
3. Some are not familiar with new features in MicroStation V8, and had difficulty finding some commands.
4. There were concerns about WSDOT resources not being completely ready when V8 was put into production.
5. There are suggestions for sharing office/user defined cell libraries with others and for allowing user-defined cells to be included in the state cell library.

R) MicroStation Levels:

1. People want more standard levels as well as more user definable levels.
2. Those that understand level filters prefer the approach of one element per level as a new standard for WSDOT.

S) MicroStation Basemaps:

1. Some offices are using multiple basemaps in order to gain more levels with MicroStation V7 and to allow multiple users and support groups to work in a project.
2. Some Traffic offices are copying basemaps to plan sheets, which creates problems when the design changes. Others are using a static version of the design basemap and not necessarily receiving latest design changes.
3. The most successful Traffic offices are referencing the design office's live basemap.

T) Quantity & Estimating Technologies:

1. The tools are effective and improved from earlier versions, but can still be cumbersome. Some people are using MicroStation to create Snotes and Qtab sheets instead of the Excel application.
2. Some do not like that Excel capabilities are disabled by the Qtab & Snote application.
3. Linking quantities between applications would eliminate redundant entry and reduce errors. Some would like to also link CAiCE and MicroStation data to cost estimate tools.
4. There are questions about who to contact for support or suggestions for cost estimate tools.
5. Some cost history is missing in Ebase because of standard item name changes.
6. There was not a lot of interest in having additional tools for cost history analysis.

U) Construction Technology:

1. There is mixed response to the value of laptops or PDAs for inspectors. Some use and see value for IDR's, forms in general, manuals, and project data. Some offices have provided laptops to inspectors but they are not being used. Primary concerns are weather, screen visibility, and security.
2. There is a general lack of knowledge about current technologies that could benefit construction administration.
3. Some people see value for inspectors to have digital voice recorders.
4. Those using prismless total stations and GPS are experiencing an increase in efficiency and safety for construction surveying.

Procedural & Training

V) Asbuilts:

1. Scanned images would be good, but most feel that asbuilts prepared in CAD would be much more valuable. Time, resources, and management support are lacking to do asbuilts in CAD. There are a few people that have done asbuilts in CAD and others indicated willingness if given guidance to do so.
2. In general, asbuilts are considered an afterthought. Limited time and resources are going to this activity. There is a general lack of trust in the accuracy of asbuilts, although, there are some who think their inspectors are producing good asbuilts.
3. There was a high degree of frustration with the current asbuilt process. People think the Department could be much more efficient with future project development if good quality, electronic asbuilts were available.

W) Archiving electronic project data:

1. The predominate archiving practice is to copy project data to CD's and store in a file cabinet
2. Smaller regions do have procedures in place to archive CAD files on a central region server.
3. Electronic project data is not getting cleaned up or documented at project milestones. There is a lack of trust in archived design & survey data because documentation is lacking.
4. There is a high degree of frustration that the agency does not have policy and procedures in place for archiving electronic engineering data.

5. There is strong endorsement for implementing an agency wide file management and naming process..
6. There are suggestions to consider GIS as a method to archive data.
7. Time and resources for archiving are lacking. There is a schedule driven attitude; the next project is more important than closure of last project. The same is true for asbuilts.

X) R/W Plans & Process

1. There are many frustrations with the process. People consider it inefficient, ineffective and outdated, and would like to see the process improved.
2. People want R/W plans available in CAD, and don't understand why they don't receive CAD files back from HQ.
3. Some wonder if electronic signature technology could address the R/W plan legal issues that currently require a paper document.

Y) Plans Prep Manual:

1. Inconsistency between text and examples is a problem, and is leading to disagreements between designers, CAD operators, and reviewers.
2. There is confusion over whether the Plans Prep Manual is a guide or is policy.
3. Most people saw value for having the manual.
4. Some suggested manual improvements included putting examples on the intranet, and structuring the manual around one good example project.

Z) Hydraulics & Drainage Design Process:

1. There are questions about when the highway runoff manual will be complete
2. There are questions regarding the status of CAiCE Visual Drainage and training. Some people did not know the Visual Drainage module is available.

AA) Survey Standards & Training:

1. There is mixed response to having survey equipment standards.
2. Datum issues appear to be a large factor in many survey data problems.
3. There is concern about the lack of GPS/RTK procedures & specifications.
4. There is concern about the lack of Carlson SurvCE training & procedures.
5. More complex survey technology is requiring more skilled survey crews. Crew turnover as noted under Project Collaboration, item C3, contributes to this problem.

AB) Training Issues:

1. In general, people were satisfied with the quality of CAE & other WSDOT training.
2. The timeliness of training is the problem - it's not available when needed. There is desire for more "just in time" training tools. Those who had used the CAE web based training liked them and would like to see more developed.
3. Training is not being applied soon enough in many cases because of project timing.
4. People working in both design and construction expressed difficulties relearning design tools after they have not used them for a while.
5. Many people are teaching themselves or using office mentors to learn CAE software.
6. There were several comments that people may know how to "push the buttons" but don't necessarily understand the process.
7. Some people want more training on basic design, drafting & survey principles.

8. Experienced CAD operators would like to receive training on advanced MicroStation tools and techniques.
9. In general, there is a lack of awareness or time and interest to use CAE training resources on the web.
10. Some people think that CAE user groups and “fairs” should have course code in ATMS in order to gain management support for attendance.
11. Major upgrades and new technologies should not be implemented without training being available. The Carlson data collector, GPS, and MicroStation V8 are some examples where people felt training was not readily available.
12. People expressed need for more cross training, rotational training and office mentoring.

Successes and Best Practices

People were also asked to provide input on what is working well, and the best practices they had implemented that could benefit others. Although some are listed by region, these may be occurring in other regions as well, and just were not made known to the review team.

- An Olympic Region design office has developed an Access database for tracking project basemap changes and communicating changes with support groups. They have also developed a database to track & manage plan review comments.
- The North Central Region has defined consistent procedures for preparing staking notes for construction.
- Eastern Region designers are spending time reviewing their project with surveyors in the field, resulting in improved communication of field data needs.
- Regions with experienced party chiefs leading crews have less survey related issues.
- The CADD coordinators in North Central and South Central review project CAD files prior to plan review process, which reduces plan prep & cosmetic problems with the plans prior to the full review.
- Some users document their individual methods and procedures for the next time they use CAiCE.
- Some offices are using office mentoring to provide “on the job” training.
- Some users have organized informal MicroStation & CAiCE support groups within their region to share successes and resolve technical problems.

Appendix B: WSDOT Survey Results

The primary target audience for the survey was project office personnel performing activities listed in the scope and approximately 75 to 80 percent of the participants were from design and construction offices. The remaining 20 to 25 percent were from region & HQ support offices such as Traffic, R/W, Plans, and Bridge. The survey received 396 responses.

The survey presented 48 selected work activities within six different areas: data collection, design, quantities & estimates, plans production, project ad & closure, and construction. Participants were asked to rate the effectiveness of work activities and were given the opportunity to describe what they would do to improve the effectiveness of these activities.

People were also asked to only complete the sections that they had experience with performing. The actual number of responses for each section ranged from a low of 90 to a high of 165.

Activity Effectiveness Ratings

People rated the effectiveness of data flow, technologies, and procedures for each of the 48 activities.

- Data Flow: How effective is the flow of incoming and outgoing data for the activity?
- Technologies: How effective is technology in supporting performance of the activity?
- Procedures: How effective are procedures in defining how the activity is to be performed?

The table on the following page shows the scoring results of all 48 activities for each of the above items. Activities scoring less than 60% effectiveness in any category are highlighted.

Written Comments

The survey contained several open-ended questions and generated nearly 500 written comments and suggestions. The question below, which followed the effectiveness rating for each group of activities, received the most responses.

If you could do anything to improve the effectiveness of any of the above activities, what would you change?

(The written comments are available on-line via the WSDOT intranet at the following link:

<http://www.wsdot.wa.gov/eesc/cae/>

Survey Results of Activity Effectiveness Ratings

Item #	Process	Work Activity	Category	Effective	Ineffective
01a	Data Collection	Conduct Location Survey	Data Flow	78%	22%
01b	Data Collection	Conduct Location Survey	Technologies	85%	15%
01c	Data Collection	Conduct Location Survey	Procedures	67%	33%
02a	Data Collection	Initiate and process Photogrammetry data	Data Flow	77%	23%
02b	Data Collection	Initiate and process Photogrammetry data	Technologies	81%	19%
02c	Data Collection	Initiate and process Photogrammetry data	Procedures	66%	34%
03a	Data Collection	Acquire asbuilts & R/W plans	Data Flow	50%	50%
03b	Data Collection	Acquire asbuilts & R/W plans	Technologies	53%	47%
03c	Data Collection	Acquire asbuilts & R/W plans	Procedures	37%	63%
04a	Data Collection	Process data to create basemap	Data Flow	78%	22%
04b	Data Collection	Process data to create basemap	Technologies	79%	21%
04c	Data Collection	Process data to create basemap	Procedures	66%	34%
05a	Data Collection	Acquire traffic & accident data	Data Flow	55%	45%
05b	Data Collection	Acquire traffic & accident data	Technologies	54%	46%
05c	Data Collection	Acquire traffic & accident data	Procedures	48%	52%
06a	Data Collection	Acquire data from other agencies	Data Flow	26%	74%
06b	Data Collection	Acquire data from other agencies	Technologies	36%	64%
06c	Data Collection	Acquire data from other agencies	Procedures	24%	76%
07a	Design	Design horizontal alignment	Data Flow	83%	17%
07b	Design	Design horizontal alignment	Technologies	84%	16%
07c	Design	Design horizontal alignment	Procedures	80%	20%
08a	Design	Design roadway profiles & supers	Data Flow	79%	21%
08b	Design	Design roadway profiles & supers	Technologies	76%	24%
08c	Design	Design roadway profiles & supers	Procedures	74%	26%
09a	Design	Design roadway template	Data Flow	80%	20%
09b	Design	Design roadway template	Technologies	68%	32%
09c	Design	Design roadway template	Procedures	66%	34%
10a	Design	Develop roadway x-sections	Data Flow	78%	22%
10b	Design	Develop roadway x-sections	Technologies	73%	27%
10c	Design	Develop roadway x-sections	Procedures	69%	31%
11a	Design	Calc earthwork quantities	Data Flow	74%	26%
11b	Design	Calc earthwork quantities	Technologies	66%	34%
11c	Design	Calc earthwork quantities	Procedures	61%	39%
12a	Design	Develop hydraulic report	Data Flow	41%	59%
12b	Design	Develop hydraulic report	Technologies	54%	46%
12c	Design	Develop hydraulic report	Procedures	38%	62%
13a	Design	Design drainage systems	Data Flow	50%	50%
13b	Design	Design drainage systems	Technologies	53%	47%
13c	Design	Design drainage systems	Procedures	48%	52%
14a	Design	Calc R/W and parcel takes	Data Flow	66%	34%
14b	Design	Calc R/W and parcel takes	Technologies	76%	24%
14c	Design	Calc R/W and parcel takes	Procedures	63%	37%
15a	Design	Provide data to CAD Operators	Data Flow	67%	33%
15b	Design	Provide data to CAD Operators	Technologies	64%	36%

15c	Design	Provide data to CAD Operators	Procedures	63%	37%
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Item #	Process	Work Activity	Category	Effective	Ineffective
16a	Design	Exchange data w/ Util, Env, Traffic, Bridge	Data Flow	40%	60%
16b	Design	Exchange data w/ Util, Env, Traffic, Bridge	Technologies	51%	49%
16c	Design	Exchange data w/ Util, Env, Traffic, Bridge	Procedures	29%	71%
17a	Quant & Estimate	Calculating preparation items	Data Flow	70%	30%
17b	Quant & Estimate	Calculating preparation items	Technologies	78%	22%
17c	Quant & Estimate	Calculating preparation items	Procedures	69%	31%
18a	Quant & Estimate	Calculating grading items	Data Flow	78%	22%
18b	Quant & Estimate	Calculating grading items	Technologies	66%	34%
18c	Quant & Estimate	Calculating grading items	Procedures	74%	26%
19a	Quant & Estimate	Calculating drainage & sewer items	Data Flow	68%	32%
19b	Quant & Estimate	Calculating drainage & sewer items	Technologies	69%	31%
19c	Quant & Estimate	Calculating drainage & sewer items	Procedures	66%	34%
20a	Quant & Estimate	Calculating surfacing & pavement items	Data Flow	87%	13%
20b	Quant & Estimate	Calculating surfacing & pavement items	Technologies	72%	28%
20c	Quant & Estimate	Calculating surfacing & pavement items	Procedures	77%	23%
21a	Quant & Estimate	Calculating traffic items	Data Flow	60%	40%
21b	Quant & Estimate	Calculating traffic items	Technologies	61%	39%
21c	Quant & Estimate	Calculating traffic items	Procedures	58%	42%
22a	Quant & Estimate	Calculating other items	Data Flow	67%	33%
22b	Quant & Estimate	Calculating other items	Technologies	71%	29%
22c	Quant & Estimate	Calculating other items	Procedures	67%	33%
23a	Quant & Estimate	Preparing quantity tab sheets	Data Flow	67%	33%
23b	Quant & Estimate	Preparing quantity tab sheets	Technologies	63%	37%
23c	Quant & Estimate	Preparing quantity tab sheets	Procedures	68%	32%
24a	Quant & Estimate	Preparing structure note sheets	Data Flow	66%	34%
24b	Quant & Estimate	Preparing structure note sheets	Technologies	61%	39%
24c	Quant & Estimate	Preparing structure note sheets	Procedures	67%	33%
25a	Quant & Estimate	Preparing engineer's estimate	Data Flow	72%	28%
25b	Quant & Estimate	Preparing engineer's estimate	Technologies	75%	25%
25c	Quant & Estimate	Preparing engineer's estimate	Procedures	71%	29%
26a	Plans Production	Receiving design data for CAD file	Data Flow	59%	41%
26b	Plans Production	Receiving design data for CAD file	Technologies	71%	29%
26c	Plans Production	Receiving design data for CAD file	Procedures	62%	38%
27a	Plans Production	Creating and updating CAD basemap	Data Flow	71%	29%
27b	Plans Production	Creating and updating CAD basemap	Technologies	77%	23%
27c	Plans Production	Creating and updating CAD basemap	Procedures	63%	37%
28a	Plans Production	Drafting proposed R/W plans	Data Flow	63%	37%
28b	Plans Production	Drafting proposed R/W plans	Technologies	79%	21%
28c	Plans Production	Drafting proposed R/W plans	Procedures	55%	45%
29a	Plans Production	Drafting Plans for Approval	Data Flow	85%	15%
29b	Plans Production	Drafting Plans for Approval	Technologies	95%	5%
29c	Plans Production	Drafting Plans for Approval	Procedures	82%	18%
30a	Plans Production	Drafting Bridge Site Data plan	Data Flow	68%	32%
30b	Plans Production	Drafting Bridge Site Data plan	Technologies	82%	18%
30c	Plans Production	Drafting Bridge Site Data plan	Procedures	68%	32%

Item #	Process	Work Activity	Category	Effective	Ineffective
31a	Plans Production	Drafting Contract Plans - Roadway	Data Flow	90%	10%
31b	Plans Production	Drafting Contract Plans - Roadway	Technologies	95%	5%
31c	Plans Production	Drafting Contract Plans - Roadway	Procedures	86%	14%
32a	Plans Production	Drafting Contract Plans - Traffic	Data Flow	67%	33%
32b	Plans Production	Drafting Contract Plans - Traffic	Technologies	87%	13%
32c	Plans Production	Drafting Contract Plans - Traffic	Procedures	68%	32%
33a	Plans Production	Sharing CAD files with support orgs	Data Flow	54%	46%
33b	Plans Production	Sharing CAD files with support orgs	Technologies	72%	28%
33c	Plans Production	Sharing CAD files with support orgs	Procedures	50%	50%
34a	Plans Production	Receiving Consultant CAD files	Data Flow	26%	74%
34b	Plans Production	Receiving Consultant CAD files	Technologies	35%	65%
34c	Plans Production	Receiving Consultant CAD files	Procedures	28%	72%
35a	Plans Production	Plotting CAD files	Data Flow	83%	17%
35b	Plans Production	Plotting CAD files	Technologies	82%	18%
35c	Plans Production	Plotting CAD files	Procedures	77%	23%
36a	Ad & Closure	Distributing plans for review	Data Flow	75%	25%
36b	Ad & Closure	Distributing plans for review	Technologies	76%	24%
36c	Ad & Closure	Distributing plans for review	Procedures	64%	36%
37a	Ad & Closure	Reviewing plans & providing comments	Data Flow	69%	31%
37b	Ad & Closure	Reviewing plans & providing comments	Technologies	70%	30%
37c	Ad & Closure	Reviewing plans & providing comments	Procedures	43%	57%
38a	Ad & Closure	Printing and signing by engineer	Data Flow	69%	31%
38b	Ad & Closure	Printing and signing by engineer	Technologies	73%	27%
38c	Ad & Closure	Printing and signing by engineer	Procedures	64%	36%
39a	Ad & Closure	Process signed plan set for printing	Data Flow	72%	28%
39b	Ad & Closure	Process signed plan set for printing	Technologies	77%	23%
39c	Ad & Closure	Process signed plan set for printing	Procedures	72%	28%
40a	Ad & Closure	Archiving project data for future use	Data Flow	35%	65%
40b	Ad & Closure	Archiving project data for future use	Technologies	71%	29%
40c	Ad & Closure	Archiving project data for future use	Procedures	25%	75%
41a	Ad & Closure	Preparing data for handoff to construction	Data Flow	65%	35%
41b	Ad & Closure	Preparing data for handoff to construction	Technologies	68%	32%
41c	Ad & Closure	Preparing data for handoff to construction	Procedures	53%	47%
42a	Construction	Receiving data from design office	Data Flow	50%	50%
42b	Construction	Receiving data from design office	Technologies	72%	28%
42c	Construction	Receiving data from design office	Procedures	48%	52%
43a	Construction	Generating staking reports	Data Flow	60%	40%
43b	Construction	Generating staking reports	Technologies	60%	40%
43c	Construction	Generating staking reports	Procedures	57%	43%
44a	Construction	Providing data to contractors	Data Flow	57%	43%
44b	Construction	Providing data to contractors	Technologies	57%	43%
44c	Construction	Providing data to contractors	Procedures	61%	39%
45a	Construction	Staking out project by survey crew	Data Flow	77%	23%
45b	Construction	Staking out project by survey crew	Technologies	78%	22%
45c	Construction	Staking out project by survey crew	Procedures	74%	26%

Item #	Process	Work Activity	Category	Effective	Ineffective
46a	Construction	Project inspection	Data Flow	66%	34%
46b	Construction	Project inspection	Technologies	58%	42%
46c	Construction	Project inspection	Procedures	70%	30%
47a	Construction	Contract Administration	Data Flow	75%	25%
47b	Construction	Contract Administration	Technologies	64%	36%
47c	Construction	Contract Administration	Procedures	68%	32%
48a	Construction	Processing asbuilts & final records	Data Flow	43%	57%
48b	Construction	Processing asbuilts & final records	Technologies	40%	60%
48c	Construction	Processing asbuilts & final records	Procedures	44%	56%

The following question preceded the activity categories and prompted people to measure the effectiveness of each work activity within the category.

Please rate the effectiveness of data flow, technologies, and procedures for work activities listed below. Provide answers for only those activities that you have experience performing.

DEFINITIONS:

DATA FLOW: Incoming data that you gather or receive from others to perform a work activity, or outgoing data that is supplied to another activity.

TECHNOLOGIES: Computer applications such as; CAiCE, MicroStation, Ebase, CCIS, that are used to accomplish the work.

PROCEDURES: Office, region, or department wide policies, instructions, or training on how the work should be performed.

QUESTIONS FOR MEASURING EFFECTIVENESS:

- Is unnecessary manipulation or reformatting required of any electronic data that flows out of this activity?
- Is there manual data entry or processes that could be done more efficiently electronically, or vice versa?
- Do the technologies help or hinder accomplishment of the activity in an efficient manner?
- Is there work that is redone or duplicated by others because of technologies that are incompatible?
- Are there well defined procedures that help you accomplish the work and generate consistent results?
- Is there a lack of procedures which is causing inconsistent results and/or work to be redone?

Appendix C: Consultant Survey Results

The following list of consulting firms responded to the consultant survey. Some provided input about the civil software they use and how they meet WSDOT requirements for electronic engineering files.

Consultant	Preferred Design Software	Preferred CAD Software	WSDOT Stds?	Comment
Anderson Perry & Associates, Inc.	Land Desktop	AutoCAD	No Input	
BERGER/ABAM	Land Desktop	AutoCAD	Convert	
Bright Engineering, Inc.	Land Desktop	AutoCAD	No Input	
CES, Inc.	EaglePoint	AutoCAD	Convert	
CH2M HILL	InRoads	MicroStation	Use stds	
CTS Engineers, Inc.	Land Desktop	AutoCAD	No Input	
David Evans and Associates, Inc.	no preference	no preference	Use stds?	Conflicts with software use input
DMJM+HARRIS	InRoads	MicroStation	Use stds	
Earth Tech	no preference	no preference	Use stds	
Entranco	InRoads	None	Use stds	
Exeltech Consulting, Inc.	Land Desktop	AutoCAD	Use stds	
H.W.Lochner, Inc	Land Desktop	None	Use stds	
HDR Engineering	InRoads	MicroStation	Use stds	
HNTB Corp.	InRoads	MicroStation	Use stds	
Huitt-Zollars, Inc.	Land Desktop	AutoCAD	Convert	
HWA GeoSciences Inc.				No input for these questions
INCA Engineers, Inc.	Land Desktop	AutoCAD	Use stds	
Jacobs Civil Inc.	no preference	no preference	Use stds	Use LDD or InRoads
J-U-B Engineers	no preference	AutoCAD	Use stds	
KBA, Inc.				No input for these questions
KPFF Consulting Engineers	Land Desktop	AutoCAD	No Input	
Magnusson Klemencic Associates	GEOPAK	MicroStation	Use stds	
No name provided #1	Land Desktop	AutoCAD	Convert	
No name provided #46	InRoads	AutoCAD	No Input	
No name provided #9	Land Desktop	AutoCAD	Use stds	
Otak, Inc	Land Desktop	AutoCAD	Convert	
Pacific Surveying & Engineering	Land Desktop	AutoCAD	Use stds	
Parametrix	Land Desktop	MicroStation	Use stds?	Conflicts with software use input
Parsons Brinckerhoff, Inc.	no preference	no preference	Use stds	
Perteet Engineering	EaglePoint	AutoCAD	Varies	Varies by WSDOT office
Peterson Consulting Engineers	Land Desktop	AutoCAD	Not required	
Professional Service Industries Inc.				No input for these questions
Reid Middleton, Inc.	EaglePoint	AutoCAD	Use stds	
Rogers Surveying INC. P.S.	Don't use	AutoCAD	Not required	
Skillings-Connolly, Inc.	EaglePoint	AutoCAD	Use stds	
Taylor Engineering, Inc.	Land Desktop	AutoCAD	Convert	
Transportation Planning & Engineering, Inc.	Don't use	AutoCAD	No Input	
USKH, Inc.				No input for these questions

The survey also received many written comments about the software consultants use and their experience working with WSDOT. Please contact Jon Bauer, bauerj@wsdot.wa.gov, (360) 709-8001, to request this information.

Appendix D: Review Team & Interview Participants

The CAE Review team members are:

Region:	Name:	Position
HQ	Jon Bauer	WSDOT CAE Support Manager
HQ	Roger Caddell	Survey Support
HQ	Kate Severson	CAiCE Support
HQ	Scott Soper	MicroStation Support
NWR	Rob Harris	NWR CAE Support Manager
NWR	Dennis Melby	NWR CAE Support
ER	Pat Hoy	ER CAE Support
HQ	Randy Dubigk	Construction Documentation Engineer
	Wendell Gardner	Bentley Systems
	Ron Gant	Bentley Systems
	Mathews Mathai	Autodesk

The following people participated in one of the eleven interview sessions

Region:	Name:	Job Duties:	Yrs with WSDOT
SWR	Blane Long	Project Development Training Coordinator	20
SWR	Paul Harrison	Designer	13
SWR	Dave Medack	Region Construction/Documentation Engr	25
SWR	Bonnie Wyman	CADD	14
SWR	Daryl DeMestre		
SWR	Ray Barker	CADD	
SWR	Joel Maul	Designer	25
SWR	Dave Bellinger	SWR Engineering Services Engr	
SWR	Samih Shilbayeh	Asst. Proj Development Engineer	14
SWR	Phil Walker	Design, PSE, CADD	20
SWR	Marc Aerts	Team Leader/Project Inspector	8
SWR	Neil Francis	Survey Team Leader	23
OR	Thomas Kerr	TT3 CAD	2.25
OR	Andy Kramer	TE2 Contract Payments	17
OR	Kent Kalisch	TE2 Project Inspector, Designer	20
OR	Roscoe Ames	CAiCE Coordinator	14
OR	Jeff Graham	CAiCE Coordinator	15
OR	Darcy Muehlbauer	TE2 Design, Design Inspector	6.5
OR	Brian Register	E3 Design Team Leader	
OR	Todd Brown	E2 Project Designer/Construction Support	6
OR	Dewayne Matlock	E3 Design and Construction	13

Region:	Name:	Job Duties:	Yrs with WSDOT
OR	Cecilia McNeil	CADD PS&E	3
OR	Mandy Simons	Materials	4
OR	Steve Palmen	RW & Survey Manager, Olympic Region	18
OR	Scott Shannon	Design	
OR	Mike Miner	Operations	20
OR	Mike Carl	Oly Design	18
OR	Mike Sweeney	Oly Design	26
OR	Steve Wasmundt	R/W Plans	18
NWR	Tracy Timm	Land Survey Supervisor	26
NWR	Bill McKinney	Construction	13
NWR	Pedro Arango	Design	3
NWR	Kevin Ford	Construction CAiCE/Microstation, etc	19
NWR	Pete Schuerhoff	Design	17
NWR	Joan Oestreich	R/W Plan Reviewer	13
NWR	Susan Hill	Traffic Operations	13
NWR	Laurinda Anglin	Traffic - Sign Design	13
NWR	Keith Calais	Traffic - Electrical Design	11
NWR	Khanh Nguyen	Traffic - Electricak Design	4
NWR	Kendall McLean	CADD, Etc.	
NWR	Mary Ann Reddell	Plan Review	20
NWR	Steve Howard	Plan Review	29
NWR	Manny Quinterio	Design Team Leader	
NWR	Alex O. Sellman	R/W Land Survey - Boundary & Resolution	12
NWR	Clare Fraenzl	Design/ PS&E	10
NWR	Joyce Trawle	Design - Cadd	
NWR	Brett E. Thompson	Construction - Lead CAE	5
NWR	Kevin Cronenwett	Design -Cadd	
NWR	Chi Fai Lee	Design - PS&E	3
NWR	Aaron Muchoney	Design - Cadd	4
NWR	Clay Robertson	Design - Microstation	10
NWR	Bruce McClure	Design - Microstation/CAiCE Design	2.5
NWR	Mike Hultgren	Design - Microstation	3 mo.
NWR	Kevin Corcoran	Survey	3.5
NWR	Bud Lanctot	Survey	11
NWR	Chet Shining	Survey Design	10
NWR	Bruce Brodeur	Design/Construction	12
ER	Ray McNamara	Survey, CADD, Design, PS&E, R/W	5
ER	Ryan Vincent	PS&E, Construction, Design, Survey	6
ER	Lucas Holmquist	PS&E, Construction, Design, Survey	4

Region:	Name:	Job Duties:	Yrs with WSDOT
ER	Bob Westby	PS&E, Design, Survey	13
ER	Jennifer Rostberg	PS&E, Construction	11
ER	Todd Emerson	R/W Plan, Monumentation Map Review	
ER	Dan McKernan	Design, Surveying, Construction	12
ER	Harold Harrison	Survey, Construction	19
ER	Andrew Larson	Design, Construction	10
ER	Dave Dean	Design, Construction	12
ER	Pat Hoy	CAE	21
ER	Tom Knudsen	CAE	20
ER	Jackie Hoover	CADD/CAICE	11
ER	Denny Brown	Survey Crew, Construction	11
ER	John S. Lacy	R/W Plans Section	11
ER	Mark Jones	Design R/W, CAICE Rdway Design, Const	19
ER	Chris Courtney	Project Manager	11
ER	Richard R. Schilling	Design Team Leader	12
ER	Chris Tams	Survey Crew, Designer, Construction	5
ER	Eric Sciamanda	Design Vis, Cadd, Graphics	11
ER	Becky Spangle	Traffic-Illum, Design, Cadd, PS&E	
ER	Natasha Kinser	Design Vis, Cadd	5
NCR	Irvin Alloway	Plans Review, CADD	4.5
NCR	Ken Graves	CAE Engineer	11
NCR	Miguel Castillo	Project Engineer's Office/CAICE Coordinator	10
NCR	Chris Keifenheim	Design Team Leader	4.5
NCR	Terry Warren	Survey Crew Party Chief	20
NCR	Pete Smith	Survey Crew Party Chief	12
NCR	Sterling Knipfer	Design Team Leader	5.5
NCR	Farhad Vira	Survey	10.5
NCR	Erik Howe	Project Engineer's Office/ Designer	
SCR	Alejanoro Sanguino	Design/Construction	5
SCR	John Tevis	Design	25
SCR	Kirk Holyoak	Design	12
SCR	Lee Shuman	CAE Supervisor	20
SCR	Debby Black	Design/PS&E, CADD, construction, Other	14
SCR	Tim Burglingame	Design, CAE Support	12
SCR	Larry Miller	Design	7
SCR	Gilbert Felix	Traffic Design	13
SCR	Robert Washabaugh	Project Development - Design	7
SCR	Phil Wells	I-90 Design Team	3